Introduction

Volumetric Modulated Arc Therapy (VMAT) is a radiotherapy technique that delivers intensity modulated treatments while simultaneously rotating the gantry. The simultaneous gantry rotation and dynamic MLC movement add an additional level of complexity to both the dose calculation and delivery of VMAT treatments compared to static gantry IMRT.

Because of the large number of variables available for manipulation in VMAT treatments, it has the potential to generate plans of equal or better quality than IMRT. Treatment planning studies are necessary to determine if VMAT techniques can generate plans of comparable quality to IMRT, especially for more complex treatment geometries, such as those encountered in head and neck cancers, where target volumes are in close proximity to normal tissues.

The accurate delivery of a planned treatment is an essential component of quality assurance and must be verified through measurements. Such verifications are especially relevant for complex treatment geometries. The Radiological Physics Center (RPC) has an established protocol to validate the dose delivered by complex treatment techniques, such as IMRT, using an anthropomorphic phantom.

Head and Neck Phantom

The RPC head and neck phantom (Figure 1) was evaluated by the RPC for credentialing using the head and neck phantom.

The phantom includes TLDs at each point by the treatment planning treatment volumes (PTVs) and a simulated organ at risk (OAR) structure representing the spinal cord. The primary PTV wraps around the spinal cord OAR volume.

Methods

Clinically relevant treatment plans were created for the RPC HN and head and neck phantom from typical prescription and dose constraints for Elekta VMAT planned with Pinnacle3 SmartArc, and RapidArc and IMRT planned with Eclipse. The treatment plans were evaluated to determine if they were clinically comparable using several dose metric criteria, including ability to meet dose objectives, conformity index (CI) and homogeneity index (HI).

Methods

The measured and calculated doses for each treatment plan were compared to determine if they were clinically acceptable based upon dose differences and distance-to-agreement. The measured dose at each point by the treatment planning volumes were compared with the dose generated from the corresponding calculated dose distribution. The percent of points passing the gamma analysis was also performed using the RPC protocol established by the RPC for credentialing using the head and neck phantom.

The CI for the primary PTV and the HI for both PTVs are shown in Table 1 for all three treatment plans. Lower values of CI and HI indicate more conformal or more homogenous dose distributions.

Results

The CI for the primary PTV and the HI for both PTVs are shown in Table 1 for all three treatment plans. Lower values of CI and HI indicate more conformal or more homogenous dose distributions.

Conclusions

Treatment plan quality of the Elekta VMAT, RapidArc and IMRT treatments were comparable for consistent dose prescriptions and constraints. The Elekta VMAT plan, planned with Pinnacle3 SmartArc, was more homogenous but less conformal than the RapidArc and IMRT, which were planned with Eclipse. Additionally, the dosimetric accuracy of the Elekta VMAT and RapidArc treatments was verified to be within acceptable tolerances.

References

7) Personal correspondence with A. Molineu. 05/26/2010.

Acknowledgements

This investigation was supported by PHS grants CA10953 and CA81841 awarded by the NCI, DHRH.